

Stoke Weir Hydropower Project

Water Framework Directive Assessment

Renewables First – Company

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1. Introduction

Background

- 1.1. This document accompanies a planning application plus abstraction and impoundment licence applications for a proposed hydropower scheme, fish pass and adjustable weir crest at Stoke Bardolph Weir (Stoke Weir) on the River Trent.
- 1.2. The Environment Agency's 'Guidance for run-of-river hydropower: the Water Framework Directive, nature conservation and heritage' dated December 2013 has been followed as part of this assessment.
- 1.3. The assessment will review the potential effects arising from the proposed scheme in relation to:
 - flow patterns
 - sediment availability
- 1.4. The Water Framework Directive (2000/60/EC) (WFD) was passed by the European Union in 2000. It became part of UK law in 2003 with the issue of The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003.
- 1.5. The WFD is implemented regionally by river basins. Each river basin has a River Basin Management Plan (RBMP) which is updated every six years. The RBMP documents the current status of the water bodies and the pressures affecting them. It outlines the improvements that can be made within the current management period and the programme of investigations to be carried out.
- 1.6. The fundamental objectives of the WFD that apply to surface water bodies are:
 - 1.7. Prevent deterioration of the status of water bodies
 - 1.8. Achieve at least Good ecological status and Good surface water chemical status by a set date
 - 1.9. Reduce pollution from priority substances and eliminate priority hazardous substances as defined by the European Commission
 - 1.10. In addition to the objectives above there are further standards and measures to be met in areas defined as protected areas. These areas are listed in the RBMPs.
 - 1.11. Artificial or Heavily Modified Water Bodies (AWB, HMWB) cannot achieve Good ecological status as they are unable to get close enough to the required natural conditions. Instead the aim is to achieve Good ecological potential.
 - 1.12. The RBMPs detail the Environment Agency (EA) objectives specific to each water body that are designed to meet the WFD objectives. The proposed measures to meet the objectives are also given.

Purpose of assessment

- 1.13. This assessment has been undertaken to fulfil the requirements under the Water Framework Directive.
- 1.14. The EU Water Framework Directive requires environmental objectives be set for all surface and ground waters to enable them to achieve Good status or potential for heavily modified water bodies by a defined date. One objective is to prevent further deterioration which can include changes to flow pattern, width and depth of channel, sediment availability/transport and ecology and biology.
- 1.15. This assessment looks at the current status of the water bodies that may be affected by the proposed hydropower system and discusses whether or not the proposal will deteriorate the ecological quality of the water bodies or prevent the water bodies from achieving Good ecological status.
- 1.16. Any EA defined objectives and measures that are specific to the water body will be considered to determine if the proposed hydropower system will prevent these objectives and measures from being realised.
- 1.17. The assessment includes any cumulative or in-combination effects.

Site description

- 1.18. The application site is located at Stoke Weir which on the River Trent in Nottinghamshire. The river at this point comprises a weir and a canal lock separated by a man-made lock island. The lock channel is located along the left bank.
- 1.19. The weir serves the purpose of maintaining levels for navigation upstream of the weir.

Current WFD status

| | |
|--------------------------------|-----------------------------|
| Water body name | Trent from Soar to The Beck |
| Water body ID | GB104028053110 |
| Management catchment | Trent and Lower Erewash |
| River basin district | Humber |
| Hydromorphological designation | Heavily modified |
| Current ecological quality | Moderate |
| Current chemical quality | Good |
| Ecological quality objective | Moderate by 2015 |
| Chemical quality objective | Good by 2015 |

| Classification Item | 2013 | 2014 | 2015 | 2016 |
|--|-------------------------|------------------|------------------|------------------|
| Overall Water Body | Moderate | Moderate | Moderate | Moderate |
| Ecological | Moderate | Moderate | Moderate | Moderate |
| Supporting elements (Surface Water) | Moderate | Moderate | Moderate | Moderate |
| Mitigation Measures Assessment | <u>Moderate or less</u> | Moderate or less | Moderate or less | Moderate or less |
| Biological quality elements | Good | Moderate | Moderate | Moderate |
| Macrophytes and Phytobenthos Combined | Good | <u>Moderate</u> | Moderate | Moderate |
| Invertebrates | Good | Good | Good | High |
| Hydromorphological Supporting Elements | Supports Good | Supports Good | Supports Good | Supports Good |
| Hydrological Regime | Supports Good | Supports Good | Supports Good | Supports Good |
| Physico-chemical quality elements | Moderate | Moderate | Moderate | Moderate |
| Acid Neutralising Capacity | - | High | High | High |
| Ammonia (Phys-Chem) | Good | High | High | High |
| Biochemical Oxygen Demand (BOD) | High | High | Good | Good |
| Dissolved oxygen | High | High | Good | Good |
| pH | High | High | High | High |
| Phosphate | Poor | <u>Poor</u> | Poor | Poor |
| Temperature | High | High | Moderate | Good |

1.20. The upstream waterbodies are: Causeway Dyke Catchment (trib of Trent), Cocker Beck Catchment (trib of Trent), Devon from Cotham to Trent, Dover Beck Catchment (trib of Trent), Erewash from Gilt Brook to Trent, Fairham Brook Catchment (trib of Trent), Greet Catchment (trib of Trent), Leen from Day Brook to Trent, Ouse Dyke Catchment (trib of Trent), Polser Brook from Cotgrave Brook to Trent, Shelford Brook Catchment (trib of Trent), Slough Dyke Catchment (trib of Trent), Soar from Long Whatton Brook to Trent, Trent Bifurcation Pingleu Dyke to Winthorpe, Trent from Derwent to Soar.

1.21. The downstream waterbody is Trent from Carlton-on-Trent to Laughton Drain.

Proposal summary

1.22. The proposal comprises two Archimedes screw turbines, an adjustable weir crest, a new multi-species fish pass, a turbine house building, hydraulic channels, trash screening, access improvements, an electrical substation and underground cabling.

- 1.23. The scheme is expected to generate a peak power output of 300 kW and an average annual energy production of 2.0 GWh. This is sufficient to power 510 homes and provides an effective CO₂e saving of around 1,040 tonnes per year.

Interaction with other hydropower schemes

- 1.24. The following schemes are known to be operation, consented or within development along the River Trent:

Operational

Beeston Weir, 16 km upstream

Holme Lock, 5 km upstream

Consented

Nether Weir, 31 km downstream

Cromwell Weir, 38 km downstream

Proposed

Gunthorpe Weir, 8 km downstream

Hazelford Weir, 16 km downstream

2. Impact on WFD objectives

2.1. The following table reviews the RBMP for the relevant section 'Trent from Soar to The Beck':

| Receptor | Current status (2016 C2) | Objective | Reasons for status | Impact | Assessment |
|---|--------------------------|------------------|--|-------------------|--|
| OVERALL | Moderate | Moderate by 2015 | Unfavourable balance of costs and benefits Disproportionate burdens | No adverse impact | See individual elements below |
| Ecological | Moderate | Moderate by 2015 | Unfavourable balance of costs and benefits Disproportionate burdens | No adverse impact | See individual elements below |
| Ecological – biological quality elements | | | | | |
| Overall | Moderate | Good by 2027 | Disproportionate burdens | No adverse impact | See individual elements below |
| Macrophytes and phytobenthos combined | Moderate | Good by 2027 | Disproportionate burdens | No adverse impact | There will be no significant hydromorphological impacts of the proposal - see below. The ecological impact of changes in water level were assessed as part of the Ecological Appraisal by Fauna Forest Ecology, concluding that 'flora species are unlikely to be negatively impacted by the future increases, given that in previous years they will have been subjected to such conditions.' Overall, as there is no adverse impact on other related elements such as water quality, there will be no significant impact on macrophytes or phytobenthos. |

| | | | | | |
|--|---------------|-----------------------|--|-------------------|--|
| Invertebrates | High | Good by 2015 | - | No adverse impact | There will be no significant hydromorphological impacts of the proposal - see below. As there is no adverse impact on other related elements such as water quality, there will be no significant impact on invertebrates. |
| Ecological – hydromorphological supporting elements | | | | | |
| Overall | Supports Good | Supports Good by 2015 | - | No adverse impact | The hydromorphological impacts of the proposal were assessed by APEM, with the general conclusion that ‘Overall, modelling results indicate that the reach downstream of Stoke weir is characterised by low boundary shear stress and relatively coarse bed sediment. As such, geomorphological processes are subdued with limited entrainment and transport of bed material at most flows under existing conditions...flows are predicted to remain relatively unaffected given that the HEP scheme reaches maximum abstraction at <Q99’ Please see the Discussion for further details, including impacts due to changes in water level. Overall, there is a minor hydromorphological impact, which is not considered to cause any deterioration in the WFD status. |
| Hydrological Regime | Supports Good | Supports Good by 2015 | - | No adverse impact | See above. The hydropower scheme is a ‘run-of-river’ scheme and so will not affect the flow rate in the watercourse, except for directly at the weir. |
| Ecological – physico-chemical quality elements | | | | | |
| Overall | Moderate | Moderate by 2015 | Unfavourable balance of costs and benefits Disproportionate burdens | No adverse impact | See individual elements below |
| Biochemical oxygen demand (BOD) | Good | - | - | No adverse impact | There will be no significant impacts on aquatic species that contribute to BOD, nor any impact due to changes in DO, see below. |

| | | | | | |
|------------------|------|--------------|---|-------------------|---|
| Dissolved oxygen | Good | Good by 2015 | - | No adverse impact | APEM concluded the following: 'it is considered highly unlikely that the scheme would cause a material adverse impact on DO concentrations at the site that is sufficient to cause deterioration in the WFD status of the physicochemical element of the Trent waterbody.' Furthermore, the increased head at the weir is expected to improve DO levels downstream. |
| Temperature | Good | Good by 2015 | - | No adverse impact | Any impacts on water temperature due to changes in flow distribution will be very minor and highly localised. |

2.2. All conditions assessed above are shown to have either no impact or a positive impact on each individual WFD element.

3. Discussion

Overview

- 3.1. Stoke Weir is located within the 'Trent from Soar to The Beck' section of Nottingham Urban Operational Catchment Area. The Management catchment area is Trent and Lower Erewash within the Humber River Basin District.
- 3.2. The catchment of the Lower Trent and Erewash is a very large sub-catchment covering an area of approximately 2045 km², extending from the River Dove confluence with the River Trent south west of the city of Derby and finishing at Alkborough Flats where the Trent flows into the Humber Estuary. Within this area the River Trent is 174 km long with its main tributaries including the rivers Derwent, Soar, Erewash, Leen, Greet, Devon, Idle, Torne and Eau and the Dover Beck.
- 3.3. The Vision for the Lower Trent & Erewash Catchment Partnership is "A Lower Trent & Erewash catchment that has a healthy, functioning water environment including rivers, lakes and groundwater". A long-term objective is that "water quality from point and diffuse sources is improved" and that "fish can move freely throughout the catchment with ample spawning and nursery areas".
- 3.4. The Humber RBMP cites not setting the 2015 ecological quality target at Good due to it 'unfavourable balance of costs and benefits' and 'disproportionate burdens'.
- 3.5. The Trent Lower and Erewash Catchment Management Plan shows that the main reason for not achieving Good status is due to the catchment is failing on ecological status.
- 3.6. Key pressures include:
 - Diffuse pollution from roads and urban areas
 - Heavily modified river channels
 - Rural point source and diffuse pollution
 - Separation of the river from its floodplain
 - Loss of riparian wetland habitats
 - Raised levels of phosphates
 - Risk of properties and roads flooding
 - Impeded fish passage

Mitigation measures

3.7. When a failure is identified, a range of measures are assessed that would be needed to improve the status of water bodies. Mitigation measures proposed for this catchment are: 1

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|---|
| Improve modified physical habitats |
| <ul style="list-style-type: none"> • Removal or easement of barriers to fish migration • Removal or modification of engineering structure • Improvement to condition of channel/bed and/or banks/shoreline • Improvement to condition of riparian zone and /or wetland habitats • Changes to operation and maintenance |
| Managing pollution from waste water |
| <ul style="list-style-type: none"> • Reduce diffuse pollution at source • Reduce point source pollution pathways (i.e. control entry to the water environment) • Mitigate/remediate point source impacts on receptor |
| Manage pollution from towns, cities and transport |
| <ul style="list-style-type: none"> • Reduce diffuse pollution at source • Reduce diffuse pollution pathways (i.e. control entry to the water environment) • Mitigate/remediate diffuse pollution impacts on the receptor |
| Improve the natural flow and level of water |
| <ul style="list-style-type: none"> • Control pattern/timing of abstraction |
| Manage pollution from rural areas |
| <ul style="list-style-type: none"> • Reduce diffuse pollution at source • Mitigate/remediate diffuse pollution impacts on the receptor |

3.8 The Reasons for Not Achieving Good Status (RNAGS) within the water body are:

- Mitigation measures assessment
 - Confirmed physical modifications due to:
 - Navigation
 - Flood protection
 - Urbanisation
- Macrophytes and Phytobenthos Combined
 - Probable phosphate pollution from:
 - Waste water discharges
 - Urban transport drainage

Biodiversity and fish passage

- 3.8. The immediate area is not subject to any statutory environmental designations.
- 3.9. There are no existing fish pass facilities at Stoke Weir. The new fish pass facilities will be suitable for all species and designed to latest EA guidance with an attraction flow equal to 5% of the maximum hydropower flow.
- 3.10. The installation of the fish passes will fulfil requirements under the Salmon and Freshwater Fisheries Act 1975 and the Eels (England and Wales) Regulations 2009.
- 3.11. The proposal includes lamprey passage provisions and as such will contribute to the migration of lamprey throughout the River Trent from the Humber Estuary SAC and the upper Catchment, which includes the Attenborough Gravel Pits SSSI. This is in line with the conservation objectives of the Humber Estuary SAC.
- 3.12. The proposed weir crest operation will stabilise upstream water levels within key fish migration windows. This makes it significantly easier to install a fish pass that operates effectively across a wide range of flow conditions.
- 3.13. Overall the hydropower scheme does not create any additional barrier to fish passage and with the introduction of a new fish pass facilities, fish migration at Stoke Weir and along the Trent will improve.
- 3.14. A specialist study was commissioned from APEM to assess the impact of the proposals on aquatic habitats and fish passage, based on a detailed geomorphology assessment. A summary of their findings is presented below:
- *The fish habitat assessment focused on potential impacts to adult, juvenile and spawning life stages of rheophilic coarse fish species, roach, and lamprey established during discussions with the EA.*
 - *Overall, the habitat assessment indicates that the proposed HEP scheme would result in a decrease in areas of suitable habitat for rheophilic and lamprey spawning at low flows (Q95 – Q75), which is driven primarily by the proposed increase in the downstream water level, resulting in sub-optimal water depths. A small decrease in habitat suitability for adult rheophilic life stages is predicted at Q95, but is predicted to remain largely unaffected at all other flows. Conversely, a modest increase in habitat suitability for juvenile rheophilic life stages is predicted at low to moderate flows (Q95 – Q50), driven by reductions in water velocity outside of the main HEP plume.*
 - *Spawning habitat for roach is largely absent from the site under the baseline conditions and is predicted to remain unchanged following construction of the HEP scheme. Moderate increases in habitat suitability for juvenile and adult life stages of roach are predicted following construction of the HEP scheme, driven by reductions in velocity outside of the main HEP flow.*
 - *Stoke weir is currently deemed a complete barrier to the upstream passage of cyprinid species, lamprey and eel at all flows due to excessive head drops and high velocities over the weir face. The structure is deemed to be a complete barrier to*

salmon and trout passage at low flows (Q95) and a partial barrier (high impact) for salmon and sea trout at moderate to high flows (Q50 and Q25).

- *Despite a reduction in the passability of the main weir structure due to the addition of an inflatable weir crest associated with the HEP scheme, the overall upstream passability at the site would increase following construction of the HEP scheme due to the addition of a multi-species fish pass and a separate eel and lamprey pass adhering to EA (2010) best practice guidance.*
- *The addition of the inflatable weir crest would not increase the maximum high water level under high flow events and thus impacts on water vole or otter populations (e.g. due to inundation of burrows) are not anticipated.*
- *The increase in upstream water levels has the potential to create a backwater effect on tributaries of the River Trent between Stoke and the next weir upstream (Holme Lock). There is one tributary – Polser Brook - that flows into the River Trent between these two structures which is encompassed within the ‘Polser Brook from Cotgrave Brook to Trent’ WFD waterbody (GB104028053230). The overall extent of any impact is likely to be relatively small, however, given the 0.47 m maximum increase in water level.*
- *EA monitoring of DO downstream of Stoke weir indicates that levels have been consistent with High WFD status during 2017 and 2018. Due to the recent DO concentrations and low HEP abstraction (maximum abstraction would occur at a flow <Q99) it is considered highly unlikely that the scheme would cause a material adverse impact on DO concentrations at the site that is sufficient to cause deterioration in the WFD status of the physicochemical element of the Trent waterbody. No adverse impacts on fish and invertebrates are anticipated.*

3.15. In summary, the development is therefore expected to result in some changes to fish habitat suitability for specific species, life stages, and flow conditions, however any reductions in suitability are offset by improvements elsewhere. In addition, the proposals will not result in any significant adverse impacts related to riparian habitats.

3.16. Furthermore, the significant improvements in fish passage at the site provide a clear benefit to fish across all species, life stages and flow conditions.

Hydromorphology

3.17. The specialist study commissioned from APEM assessed the geomorphological impact of the proposals, based on bathymetric survey data, sediment grab sampling and 2D hydraulic modelling. APEM make the following concluding statements:

- *Overall, modelling results indicate that the reach downstream of Stoke weir is characterised by low boundary shear stress and relatively coarse bed sediment. As such, geomorphological processes are subdued with limited entrainment and transport of bed material at most flows under existing conditions. This situation is not expected to change following installation of the HEP scheme and flows are*

predicted to remain relatively unaffected given that the HEP scheme reaches maximum abstraction at <Q99. Therefore, changes in flow and shear stress at moderate to high flows remain relatively unaffected.

- *There is a small risk that reductions in boundary shear stress at some locations may be sufficient to allow fine sediment (<0.062 mm in diameter) to be deposited locally during low flows (Q75 and below). However, the impact of any such deposition on bed composition is likely to be temporary as higher magnitude flows remain competent to entrain coarse sand and fine gravel at most locations. The impact on the sediment bar is also expected to be minimal as maximum modelled shear stress across the range of flow scenarios considered here is lower under proposed conditions compared with the current situation.*
- *The proposed HEP scheme includes provision of an additional inflatable weir crest to raise the upstream water level by 0.40 – 0.47 m during low to moderate flows. The increase is not expected to significantly alter the character of the upstream river channel given the occurrence of low velocity glide/pool flow under the current baseline conditions.*
- *The proposed increase in weir crest height is unlikely to have a substantial impact on coarse sediment transport processes which are of most importance in influencing channel morphology. This is because the existing structure at Stoke is likely to inhibit the majority of downstream sediment transport, and because the weir crest will not be raised during high flows (>Q10) which are responsible for the majority of coarse sediment transport.*

3.18. In summary, the proposed scheme will not result in any significant geomorphological changes outside the main development area. In addition, the ecological impacts of any minor changes have been accounted for as part of the third-party combined fisheries and geomorphology assessment. As such the WFD status will not be adversely impacted.

4. Conclusions

- 4.1. The proposed development will not impact negatively on the current status of the water body and will not have an adverse impact on meeting future WFD objectives.
- 4.2. The introduction of a multi-species fish pass with eel and lamprey facilities has been independently assessed to provide a significant positive improvement to fish passage at this site, providing opportunities for improvements more widely along the Trent.
- 4.3. Overall, the proposed development will have no impact or a positive impact on each individual element of the relevant WFD classifications.